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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B41M 5/34, H04N 1/50

A1

(11) International Publication Number: WO 97/16318

(43) International Publication Date: 9 May 1997 (09.05.97)

(21) International Application Number: PCT/GB96/02641

(22) International Filing Date: 30 October 1996 (30.10.96)

(30) Priority Data:
9522215.4 31 October 1995 (31.10.95) GB

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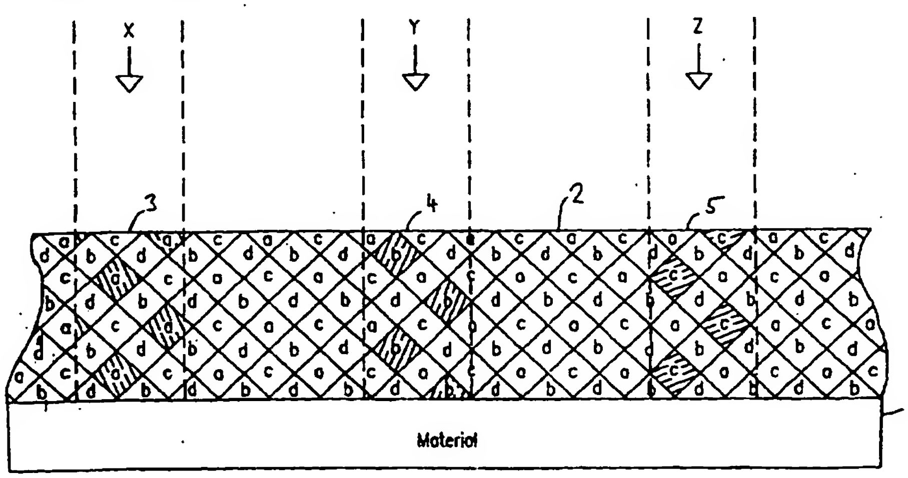
(81) Designated States: DE, GB, IL, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: APPARATUS FOR AND METHOD OF PRINTING

Representation showing method of exposure of special ink or toner.
(Where X, Y and Z represent the three ultra-violet wavelengths required to expose molecules a, b and c respectively.)



(57) Abstract

In a method of printing, an article (1) to be printed is provided with a photosensitive coating (2) including a plurality of photoreceptive materials (a, b, c) that are sensitive to electromagnetic radiation of different wavelengths (X, Y, Z) and that produce predetermined visible colours when exposed to said radiation. The image, which is stored in digitised form as a set of digital data, is generated by controlling the exposure of said photosensitive coating (2) to the radiation in accordance with the digital data. The image is then stabilised.

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APPARATUS FOR AND METHOD OF PRINTING

The present invention relates to a method of printing and an apparatus for printing. In particular, the invention relates to a digital printing method and an apparatus for printing digitally.

Digital printing techniques involve transferring a digitised image to an article to be printed. Such techniques are frequently employed where traditional offset or lithographic techniques are inappropriate. For example, digital printing may be used for one-off prints or for small print runs, where the expense and/or lead time of preparing a set of lithographic plates is disproportionately high.

Known digital printing techniques generally involve electronically transferring the printing inks directly or indirectly to the article to be printed so as to build up the desired image. For a colour image, inks of four different colours (magenta, cyan, yellow and black) are generally required and each of these is normally transferred separately to the article. This can be achieved in various different ways.

For example, in the E-Print (TM) printing system disclosed in International patent application No. PCT/NL93/00010, ionised ink droplets are transferred by electrophoresis onto a charged drum in the desired pattern, which then transfers those droplets to the article. The four colours are transferred consecutively and the process is therefore relatively slow. Also, because the printed image is made up of individual droplets of ink, solid block colours cannot be produced.

An alternative digital printing technique involves transferring the ink to the article by means of an inkjet print head. In this method, droplets of ink of the four constituent colours are propelled onto the article from a

printhead that is located a short distance away from the substrate. The droplets deform and spread slightly upon contact with the article and the definition is not therefore very high. Also, as with the E-Print system, solid block colours cannot be produced since the printed image is made up of individual droplets of ink.

A further disadvantage of both above-mentioned techniques is that neither technique is suitable for printing onto oddly-shaped objects such as bottles or other containers, or onto articles with uneven, delicate or soft surfaces, such as fabrics or foams.

It is an object of the present invention to provide a printing method and an apparatus for printing that mitigates at least some of the above-mentioned disadvantages.

According to the present invention there is provided a method of printing wherein an article is provided on which an image is to be printed, said article having a photosensitive coating including a plurality of photoreceptive materials that are sensitive to electromagnetic radiation of different predetermined wavelengths and that produce predetermined visible colours when exposed to electromagnetic radiation of said predetermined wavelengths, the article is exposed to electromagnetic radiation of said predetermined wavelengths to generate an image within said coating, and said image is stabilised, characterised in that said image is stored in digitised form as a set of digital data and the image is generated by controlling the exposure of said photosensitive coating to said electromagnetic radiation in accordance with said digital data.

Because the image is printed digitally, it is possible to print directly images that have been generated digitally,

for example using a computer. One-off prints and short print runs can therefore be printed without the high costs associated with offset printing techniques. However, because the image is generated optically within a single, homogeneous coating rather than by transferring different coloured inks to the printed article, the process is much faster than conventional digital printing techniques. Also, block colours can be produced.

Further advantages provided by the printing method include that the definition is very high and that the method can be used to print many different types of two- and three-dimensional articles.

Advantageously, said photosensitive coating includes at least three different photoreceptive materials that produce the colours red, blue and green when exposed to radiation of said predetermined wavelengths. Alternatively, said photosensitive coating may include at least four different photoreceptive materials that produce the colours magenta, cyan, yellow and black when exposed to radiation of said predetermined wavelengths.

Advantageously, said photosensitive coating is exposed to electromagnetic radiation of said predetermined wavelengths by selectively activating an array of radiation sources located in close proximity with said photosensitive coating.

Advantageously, said array is translated relative to said article, whereby each radiation source within said array exposes an area of said photosensitive coating by scanning that area in a predetermined pattern. The array may be translated relative to said article either by moving the array and keeping the article stationary or vice versa.

Advantageously, each array comprises a plurality of pulsed

semiconductor lasers. These lasers are extremely small and many can therefore be incorporated into an array. They can also be fired at very high pulse rates, for example at up to 2,000,000 pulses per second, which is important for fast printing speeds.

Advantageously, said pulsed semiconductor lasers generate infrared radiation. The materials can then be handled under normal lighting conditions without the need for special precautions.

Advantageously, said pulsed semiconductor lasers generate radiation of at least one of the following wavelengths: 820nm, 880nm, 1300nm and 1550nm. Said pulsed semiconductor lasers may, for example, be Hamamatsu Photonics diode semiconductor pulsed lasers, models PLP-03/PLDH082, PLP-03/PLDH088, PLP-01/LDH130 and PLP-01/LDH155.

In an alternative arrangement, the photosensitive coating is exposed to the electromagnetic radiation by scanning the coating in a predetermined pattern, for example a raster pattern. Only one radiation source is then required for each wavelength.

Advantageously, said different wavelengths follow a common optical path. Registration of the different colours is thus made easier and the optical arrangement is simplified.

Advantageously, said electromagnetic radiation is generated by means of a plurality of gas pulsed lasers, for example excimer lasers. Such lasers can be fired at very high pulse rates, for example at up to 100 pulses per second, and provide very high definition.

Advantageously, said gas pulsed lasers generate ultraviolet radiation. The materials can then be handled under normal lighting conditions and, because the wavelength of the

ultraviolet radiation is very short, very high definitions can be achieved.

Advantageously, said gas pulsed lasers generate radiation of at least one of the following wavelengths: 193nm, 248nm, 308nm and 351nm.

Advantageously, said gas pulsed lasers include at least one of the following types: argon fluoride, krypton fluoride, xenon chloride and xenon fluoride.

The lasers may, for example, be Lambda Physik gas pulsed excimer models: argon fluoride LPX210i, krypton fluoride LPX220i, xenon chloride LPX210i and xenon fluoride LPX210i.

Advantageously, said image is stabilised by exposing said article to electromagnetic radiation of another predetermined wavelength. Preferably, the image is stabilised by exposing the article to ultraviolet radiation.

Advantageously, the coating includes a photoreceptive ink.

Advantageously, said method includes the step of applying the coating to at least a portion of the article.

The present invention further provides an apparatus for printing an image on an article, said article having a photosensitive coating including a plurality of photoreceptive materials that are sensitive to electromagnetic radiation of different predetermined wavelengths and that produce predetermined visible colours when exposed to electromagnetic radiation of said predetermined wavelengths, said apparatus including means for receiving said article, at least one radiation source for generating electromagnetic radiation of said predetermined wavelengths, means for directing said

radiation onto said article to generate an image within said coating, and means for stabilising said image, characterised in that said apparatus includes a data storage means for storing digital data representing the image to be printed in digitised form, and control means for controlling the exposure of said article to said radiation in accordance with the digital data stored in said data storage means.

Advantageously, the apparatus includes an array of radiation sources that, in use, is located in close proximity with said photosensitive coating. Alternatively, the array may be located remotely and the radiation transmitted by, for example, optical fibres to the article.

Advantageously, the apparatus includes means for translating said array relative to said article whereby, in use, each radiation source within said array exposes an area of said digitised image by scanning that area in a predetermined pattern.

Advantageously, said array comprises a plurality of pulsed semiconductor lasers.

Advantageously, said pulsed semiconductor lasers generate infrared radiation.

Advantageously, said pulsed semiconductor lasers generate radiation of at least one of the following wavelengths: 820nm, 880nm, 1300nm and 1550nm. Said pulsed semiconductor lasers may, for example, be Hamamatsu Photonics diode semiconductor pulsed lasers, models PLP-03/PLDH082, PLP-03/PLDH088, PLP-01/LDH130 and PLP-01/LDH155.

Advantageously, the apparatus includes means for scanning said photosensitive coating with said radiation in a predetermined pattern.

Advantageously, said scanning means is arranged such that said different predetermined wavelengths follow a common optical path.

Advantageously, said radiation source includes a plurality of gas pulsed lasers, for example excimer lasers.

Advantageously, said gas pulsed lasers generate ultraviolet radiation.

Advantageously, said excimer lasers generate radiation of at least one of the following wavelengths: 193nm, 248nm, 308nm and 351nm.

Advantageously, said gas pulsed lasers include at least one of the following types: argon fluoride, krypton fluoride, xenon chloride and xenon fluoride.

The lasers may, for example, be Lambda Physik gas pulsed excimer models: argon fluoride LPX210i, krypton fluoride LPX220i, xenon chloride LPX210i and xenon fluoride LPX210i.

Advantageously, said means for stabilising the image includes means for exposing said article to electromagnetic radiation of another predetermined wavelength.

Advantageously, said means for stabilising the image includes a source of ultraviolet radiation.

Advantageously, the apparatus includes means for applying said photoreceptive coating to at least a portion of said article.

Advantageously, the apparatus includes conveyor means for conveying an article through the apparatus.

Advantageously, said apparatus has a definition of at least

800dpi and preferably 1200dpi and more preferably 2400dpi.

Embodiments of the invention will now be described with reference to the accompanying drawings, of which:

Fig. 1 is a diagrammatic cross-section through a carrier material having a photosensitive coating, for use in the printing process;

Fig. 2 is a diagrammatic cross-section through the carrier material shown in Fig. 1, during exposure of the photosensitive coating;

Fig. 3 is a flow diagram illustrating certain steps of the printing method;

Fig. 4 is a diagrammatic plan view of a printing machine according to a first embodiment of the invention, and

Fig. 5 is a diagrammatic side view of a printing machine according to a second embodiment of the invention.

As shown in Fig. 1, the carrier material comprises a substrate 1 having a photosensitive coating 2 applied to one side thereof. The coating 2 may comprise a transparent trichromatic emulsion or a photoreceptive ink or toner. Similar materials are known and are used in prior art printing techniques, such as the photographic, diazo- and cyanotype processes.

The coating 2, which is transparent prior to exposure, includes three types of photoreceptor molecule **a**, **b** and **c** and a carrier/bonding agent **d**. For clarity, these molecules are shown in a grid-like distribution: it will be understood that in practice the molecules are distributed randomly throughout the coating 2.

The photoreceptor molecules a, b and c are sensitive to different narrow bands of radiation, which are preferably in the ultraviolet or infrared parts of the electromagnetic spectrum. When radiation of the appropriate wavelength is incident on one of the photoreceptor molecules it causes a change in the structure of the molecule, which alters the optical absorption of the molecule. As a result, when an article having a coating of the photosensitive material is exposed to radiation of the appropriate wavelength, it changes colour.

The photoreceptor molecules a, b and c are selected so that upon exposure to radiation of the appropriate wavelengths, they generate the primary colours red, blue and green in the printed article. By selectively exposing the coating to radiation of the three required wavelengths and varying the intensity and/or duration of that exposure, a full range of colours can thus be produced. Alternatively, four types of photoreceptor molecules may be provided that generate the colours magenta, cyan, yellow and black.

In a preferred form of the invention, the photoreceptor molecules are sensitive to invisible radiation, for example ultraviolet or infrared radiation. Using invisible radiation provides various advantages over the use of visible light. One of these is that shielding is not generally necessary, providing that the photosensitive material is protected from accidental exposure to sources of the invisible radiation, such as sunlight. The printing operation can therefore be observed under normal lighting conditions and the materials can be handled without the need for special precautions. If the materials are sensitive to radiation that is near to the ends of the visible spectrum (for example ultraviolet radiation of 351nm wavelength), appropriate filtering may be necessary.

Fig. 2 illustrates a method of exposing the photosensitive

coating 2. Three sections 3,4,5 of the coating 2 are exposed to radiation of the wavelengths required to expose molecules a, b and c. In the first section 3, the coating 2 is exposed to radiation of a first wavelength X, to which the molecules designated a are sensitive. This causes a change in the structure of those molecules (whilst leaving molecules b and c unaffected), which results in the first section 3 taking on a first colour, for example red.

The second section 4 is exposed to radiation of a second wavelength Y, to which the molecules designated b are sensitive. The second section 4 therefore takes on a second colour, for example blue. Similarly, the third section 5 is exposed to radiation of a third wavelength Z to which the molecules designated c are sensitive, which results in the that section taking on a third colour, for example green.

Therefore, by exposing the coating 2 to the three wavelengths X, Y and Z, a full colour printed image can be produced.

The areas exposed to the different wavelengths may overlap and in those overlapping areas two or three groups of photoreceptor molecules may be exposed. This allows all the other colours including black to be produced.

If the exposure is sufficiently great, substantially all the photoreceptor molecules of the appropriate type in the exposed area will be structurally altered, and a deep tint will be produced. Lighter tints can be produced simply by reducing the intensity or the duration of the exposure, so that not all the molecules in the exposed area receive sufficient radiation to affect them. In both cases, however, block colours will be produced, as changes in exposure affect the depth of colour rather than the size of the pixels making up the printed image.

After exposure, the printed image is cured by evaporating the carrier and bonding the photoreceptor molecules to the substrate 1. This may be achieved by exposing the article to high intensity ultraviolet radiation (providing this is not of a wavelength to which the molecules a, b and c are sensitive). The ultraviolet radiation also removes a key part of the structure of the molecules a, b and c to inhibit the photosensitivity of the molecules and prevent deterioration of the image, should the image be exposed subsequently to, for example, sunlight.

Alternatively, chemical processes may be employed to develop and/or cure the printed image. For example, a latent image may be generated in a photosensitive material by exposing the material using the digital techniques described below and the image may then be developed using photographic developing and fixing processes.

The steps of the printing process are illustrated diagrammatically in Fig. 3. In the first step, the photosensitive ink or toner is applied to the article to be printed, so that is covers the area in which the printed image is to appear. Unlike a conventional printing process, the image is not built up during the process of applying the ink and this means that the ink can be applied by any suitable method, for example by spraying or using a roller. Also, only one coating of photosensitive ink has to be applied, as compared to the four different inks that are required for a lithographic print.

The articles to which the coating may be applied are numerous and almost without limit. Because the method of applying the coating does not affect the image-forming process, and the image may be created without any physical contact with the article, many different types of article may be printed, including articles with soft, uneven or easily damaged surfaces. Examples of articles that may be

printed include bottles and other containers, fabrics and foamed materials, as well as papers and other sheet materials.

It is possible to apply the coating to the articles as a pretreatment, for example during the manufacturing process. The coated areas of the articles will then have to be protected from radiation of the relevant wavelengths prior to exposure. Normally, if the coating is sensitive only to infrared or ultraviolet radiation, sunlight will be the only significant source of such radiation and it will therefore be possible to handle the materials indoors without any special shielding.

During the second stage of the printing process, the coated articles are exposed to radiation of the appropriate wavelengths to create the desired image. This image is then stabilised and cured in the third stage, as described in more detail above.

A printing machine according to a first embodiment of the invention is shown in Fig. 4. This machine includes a conveyor 9, above which there are positioned two exposure heads 10,11 and a curing head 12. The type of conveyor used depends only on the nature of the articles to be printed and may therefore take many different forms. The conveyor may be arranged to run continuously or, alternatively, it may be arranged to place articles beneath the heads 10,11 so that they are stationary during the image-forming process. The conveyor may, for example, take the form of a belt or roller conveyor or a robot arm.

Each of the exposure heads 10,11 includes an array of pulsed semiconductor lasers 13 that generate radiation at the wavelengths to which the photoreceptive molecules in the coating 2 are sensitive. For example, the first array 10 may include semiconductor lasers that operate at

infrared wavelengths of 820nm and 880nm, and the second array 11 may include infrared semiconductor lasers that operate at wavelengths of 1300nm and 1550nm. Separate arrays may alternatively be provided for each of the different types of laser, or all four types of laser may be included in one array.

Suitable semiconductor lasers for use in the arrays include Hamamatsu Photonics diode semiconductor pulsed lasers, models PLP-03/PLDH082, PLP-03/PLDH088, PLP-01/LDH130 and PLP-01/LDH155, which have operating wavelengths of 820nm, 880nm, 1300nm and 1550nm respectively.

Although the semiconductor lasers 13 are very small (less than 6mm in diameter), they cannot with present day technology be packed sufficiently closely to produce required definitions of up to about 2400dpi. Relative movement between the arrays and the article is therefore provided, by means of either stepper or servo motors 14. In the case of a printing machine with a continuously advancing conveyor, this movement may consist simply of a reciprocation of the heads 10,11 in a direction perpendicular to direction of movement of the conveyor 9, so that each laser traces a raster pattern on the article as it advances. Alternatively, if the article is stationary during exposure, the heads 10,11 may be reciprocated in two orthogonal directions above the article, so that each laser similarly exposes a small area of the coated article by tracing a raster pattern on that area.

The size of the area traced by each laser is of course dependent on the size and spacing of the lasers. The areas exposed by adjacent similar lasers overlap one another and the lasers are arranged so that every point within the boundaries of the image may be exposed to each of the four appropriate wavelengths. Therefore every point can take on

any colour, depending on the exposure of that point to each of the different wavelengths.

It is of course possible that laser arrays may be developed that include a sufficient density of lasers to generate images with the required definitions directly. In that case, it would not be necessary to provide for relative movement between the arrays and the article to be printed.

It is also envisaged that instead of mounting the semiconductor lasers in close proximity with the article to be printed, they may be located remotely and the radiation transmitted to the article by means of optical fibres. In this way the effective density of the radiation sources may be increased considerably, which may remove the need for the array to be translated relative to the article.

Each laser 13 is digitally controlled by means of a pulse modulation train, having a frequency of up to about 100kHz. Every time the laser fires, a small area (about $25\times10^{-12}m^2$) of the coating is exposed and a dot of colour is generated, the colour of the dot being dependent on the wavelength of the laser. Each such area constitutes a picture element or *pixel* of the complete printed image. By using an array of pulsed semiconductor lasers as described above, an image having a definition of more than 2400dpi can be produced.

After exposure, the article is transferred to the curing head 12, where the carrier is evaporated and the image is permanently bonded to the article. The photoreceptive molecules are structurally altered during this stage to prevent further reaction to infrared radiation. The curing head 12 may include a bank of ultraviolet lamps that cure the image by evaporating the carrier substance.

An alternative form of printing machine is shown in Fig. 5. In this machine, the arrays of semiconductor lasers are

replaced by a bank of three (or four) gas pulsed excimer lasers 15,16,17. These may, for example, be Lambda Physik gas pulsed excimer lasers models argon fluoride LPX210i, krypton fluoride LPX220i, xenon chloride LPX210i and xenon fluoride LPX210i, which have operating wavelengths in the ultraviolet of 193nm, 248nm, 308nm and 351nm respectively.

The ultraviolet radiation of the three lasers is collimated into three mirrors 18a,b,c and the combined collimated beam 19 is then scanned across the coated area of the article 1 in a raster pattern by means of a galvonomic mirror 20. The beam 19 is focused onto the surface of the article by a scanning lens 21.

The optical arrangement described above can of course be modified, for example by the inclusion of a second galvonomic mirror to cause scanning in an orthogonal direction, or by replacing the scanning lens 21 with a separate post-objective scanning lens or linear translator mounted between the mirrors 18a,b,c and the galvanomic mirrors 20.

In operation, the laser beam 19 is scanned in a raster pattern across the area of the article that is to be exposed and the lasers 15,16,17 are fired by pulse modulation trains so as to build up the digitised image. Each time one of the lasers fires a small area (about $25\times10^{-12}m^2$) of the photosensitive material is exposed and the resulting dot of colour constitutes a pixel of the complete image. Each pixel may be of any colour, depending on the exposure of that point to each of the wavelengths. The pixels may overlap one another and full block colours may thus be produced in areas of both deep and light colour.

An advantage provided by the above system over conventional printing techniques is that because a common optical path is used by the radiation from each of the lasers, correct

registration only needs to be ensured between the article printed and the optical delivery arrangement. There is normally no necessity to check registration separately for each of the different colours.

Another advantage provided by the above system is that because the wavelengths of ultraviolet radiation are shorter than those of visible light, the exposing radiation can be focused to a smaller spot, so producing a higher definition in the final print.

Claims

1. A method of printing wherein an article is provided on which an image is to be printed, said article having a photosensitive coating including a plurality of photoreceptive materials that are sensitive to electromagnetic radiation of different predetermined wavelengths and that produce predetermined visible colours when exposed to electromagnetic radiation of said predetermined wavelengths, the article is exposed to electromagnetic radiation of said predetermined wavelengths to generate an image within said coating, and said image is stabilised, characterised in that said image is stored in digitised form as a set of digital data and the image is generated by controlling the exposure of said photosensitive coating to said electromagnetic radiation in accordance with said digital data.

2. A method according to claim 1, wherein said photosensitive coating includes at least three different photoreceptive materials that produce the colours red, green and blue when exposed to electromagnetic radiation of said predetermined wavelengths.

3. A method according to claim 1, wherein said photosensitive coating includes at least four different photoreceptive materials that produce the colours magenta, yellow, cyan and black when exposed to electromagnetic radiation of said predetermined wavelengths.

4. A method according to any one of the preceding claims, wherein said photosensitive coating is exposed to electromagnetic radiation of said predetermined wavelengths by selectively activating an array of radiation sources located in close proximity with said photosensitive coating.

5. A method according to claim 4, in which said array is translated relative to said article, whereby each radiation source within said array exposes an area of said photosensitive coating by scanning that area in a predetermined pattern.

6. A method according to claim 3 or claim 4, wherein said array comprises a plurality of pulsed semiconductor lasers.

7. A method according to claim 6, wherein said pulsed semiconductor lasers generate infrared radiation.

8. A method according to claim 7, wherein said pulsed semiconductor lasers generate radiation of at least one of the following wavelengths: 820nm, 880nm, 1300nm and 1550nm.

9. A method according to any one of claims 1 to 4, wherein said photosensitive coating is exposed to electromagnetic radiation of said predetermined wavelengths by scanning said photosensitive coating in a predetermined pattern.

10. A method according to claim 9, wherein said different predetermined wavelengths follow a common optical path.

11. A method according to claim 9 or claim 10, wherein said electromagnetic radiation is generated by means of a plurality of gas pulsed lasers.

12. A method according to claim 11, wherein said gas pulsed lasers generate ultraviolet radiation.

13. A method according to claim 12, wherein said gas pulsed lasers generate radiation of at least one of the following wavelengths: 193nm, 248nm, 308nm and 351nm.

14. A method according to claim 13, wherein said gas

pulsed lasers include at least one of the following types: argon fluoride, krypton fluoride, xenon chloride and xenon fluoride.

15. A method according to any one of the preceding claims, wherein said image is stabilised by exposing said article to electromagnetic radiation of another predetermined wavelength.

16. A method according to claim 15, wherein said image is stabilised by exposing said article to ultraviolet radiation.

17. A method according to any one of the preceding claims, wherein said coating includes a photoreceptive ink.

18. A method according to claim 17, said method including the step of applying said coating to at least a portion of said article.

19. An apparatus for printing an image on an article, said article having a photosensitive coating including a plurality of photoreceptive materials that are sensitive to electromagnetic radiation of different predetermined wavelengths and that produce predetermined visible colours when exposed to electromagnetic radiation of said predetermined wavelengths, said apparatus including means for receiving said article, at least one radiation source for generating electromagnetic radiation of said predetermined wavelengths, means for directing said radiation onto said article to generate an image within said coating, and means for stabilising said image, characterised in that said apparatus includes a data storage means for storing digital data representing the image to be printed in digitised form, and control means for controlling the exposure of said article to said radiation in accordance with the digital data stored in

said data storage means.

20. An apparatus according to claim 19, including an array of radiation sources that, in use, is located in close proximity with said photosensitive coating.

21. An apparatus according to claim 20, including means for translating said array relative to said article whereby, in use, each radiation source within said array exposes an area of said digitised image by scanning that area in a predetermined pattern.

22. An apparatus according to claim 20 or claim 21, wherein said array comprises a plurality of pulsed semiconductor lasers.

23. An apparatus according to claim 22, wherein said pulsed semiconductor lasers generate infrared radiation.

24. An apparatus according to claim 23, wherein said pulsed semiconductor lasers generate radiation of at least one of the following wavelengths: 820nm, 880nm, 1300nm and 1550nm.

25. An apparatus according to claim 19, including means for scanning said photosensitive coating with said radiation in a predetermined pattern.

26. An apparatus according to claim 25, wherein said scanning means is arranged such that said different predetermined wavelengths follow a common optical path.

27. An apparatus according to claim 26 or claim 27, wherein said radiation source includes a plurality of gas pulsed lasers.

28. An apparatus according to claim 27, wherein said gas

pulsed lasers generate ultraviolet radiation.

29. A method according to claim 28, wherein said gas pulsed lasers generate radiation of at least one of the following wavelengths: 193nm, 248nm, 308nm and 351nm.

30. A method according to claim 29, wherein said gas pulsed lasers include at least one of the following types: argon fluoride, krypton fluoride, xenon chloride and xenon fluoride.

31. An apparatus according to any one of claims 19 to 30, wherein said means for stabilising the image includes means for exposing said article to electromagnetic radiation of another predetermined wavelength.

32. An apparatus according to claim 31, wherein said means for stabilising the image includes a source of ultraviolet radiation.

33. An apparatus according to any one of claims 19 to 32, including means for applying said photoreceptive coating to at least a portion of said article.

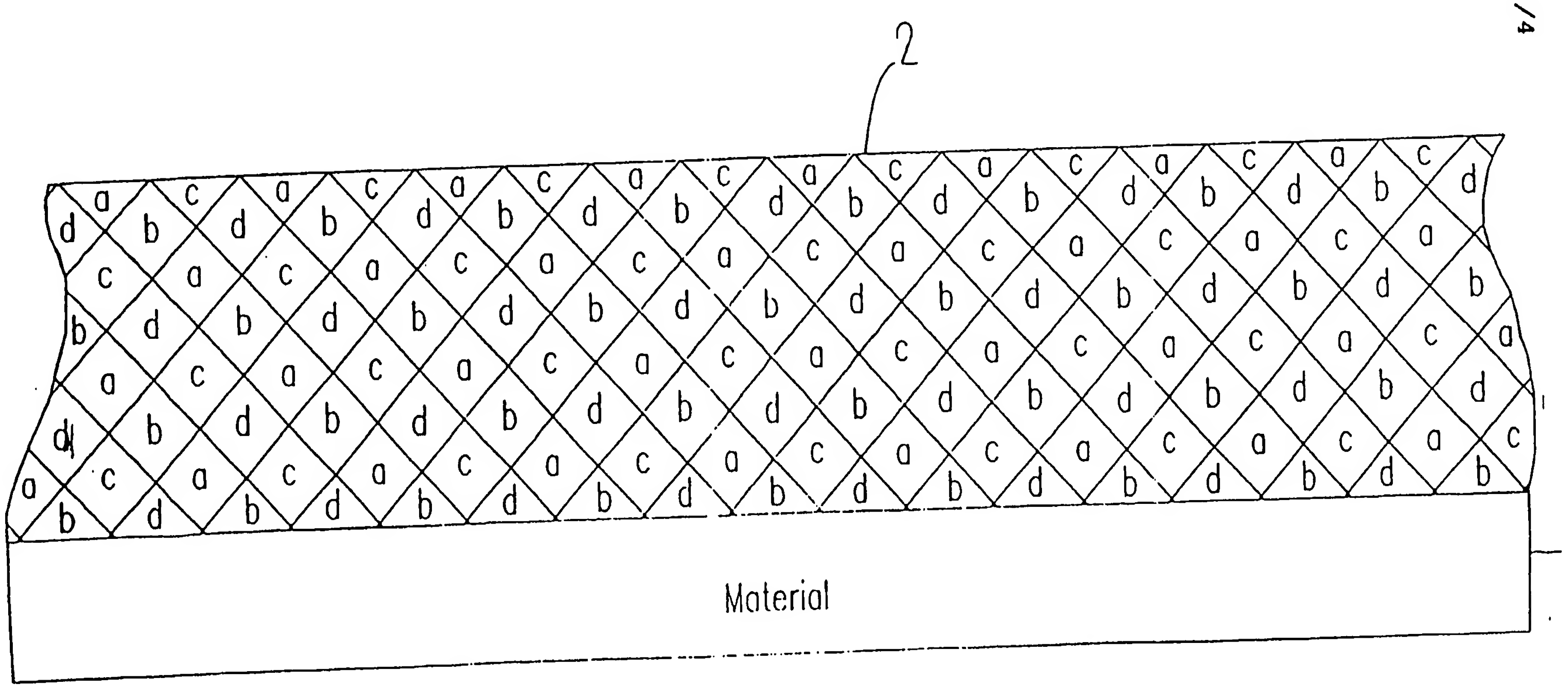
34. An apparatus according to any one of claims 19 to 33, including conveyor means for conveying an article through the apparatus.

35. An apparatus according to any one of claims 19 to 34, wherein said apparatus has a definition of at least 800dpi and preferably 1200dpi and more preferably 2400dpi.

Fig.1

Representation of component parts of special ink or toner shown in a printed layer.

(Where a, b and c represent equal quantities of the three photoreceptor molecules, whilst d represents the carrier/bonding agent.)



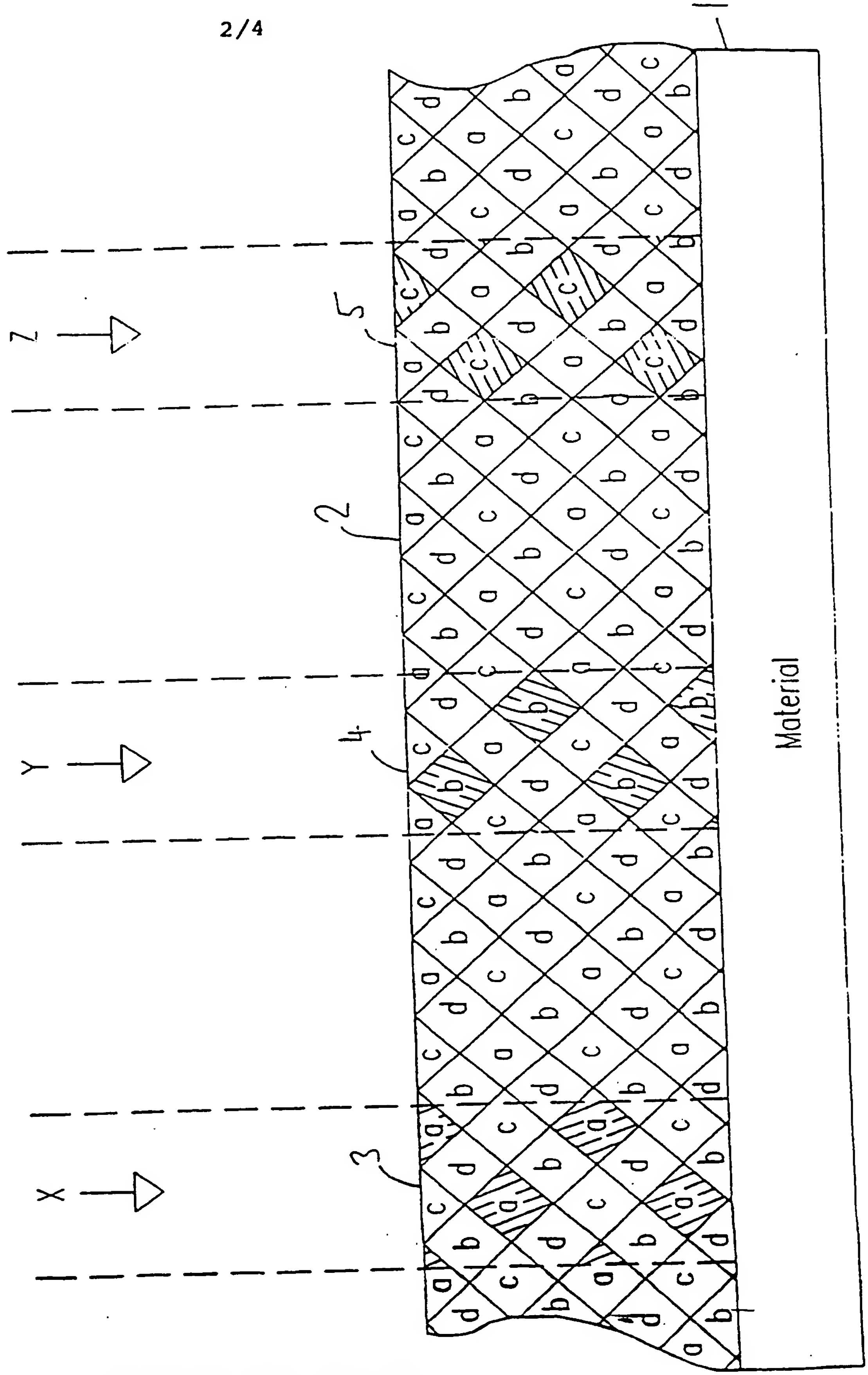
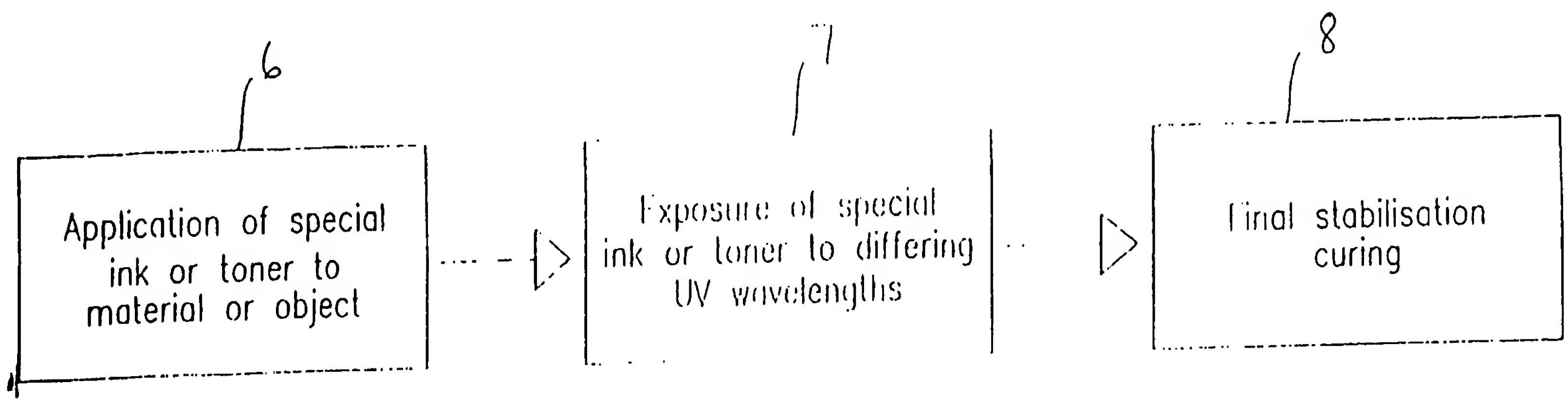


Fig. 2
Representation showing method of exposure of special ink or toner.
(Where X, Y and Z represent the three ultra-violet wavelengths required to expose molecules a, b and c respectively.)

Fig.3

Representation detailing the component parts of the process to create images on/in the special ink or toner.



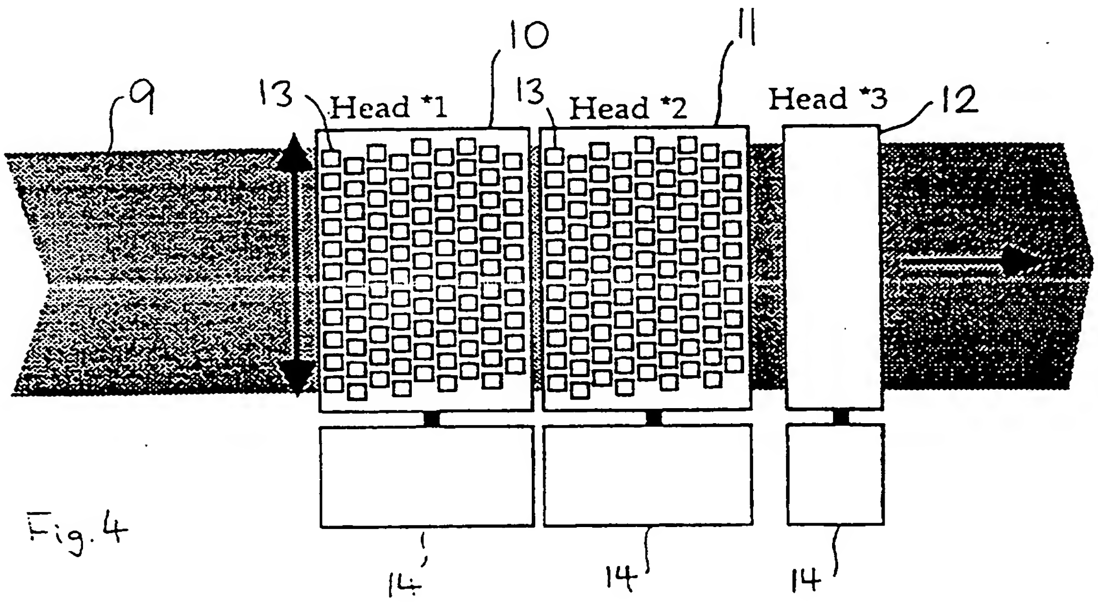

9
13
Head *1
10
13
Head *2
11
Head *3
12
14
14
14

Fig. 4

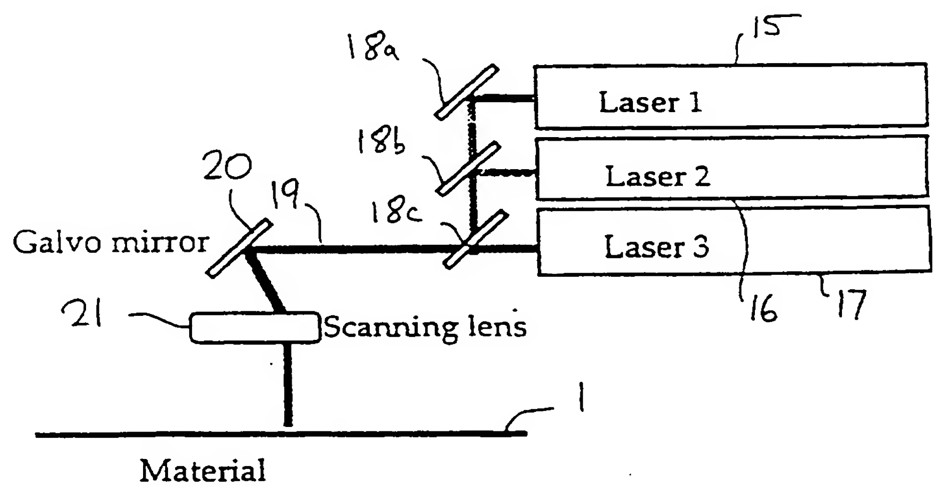

15
18a
Laser 1
18b
Laser 2
20
19
18c
Galvo mirror
Laser 3
16
17
21
Scanning lens
1
Material

Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/02641

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B41M5/34 H04N1/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B41M H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A,4 529 992 (K. ISHIDA ET AL.) 16 July 1985 see column 2, line 18 - column 3, line 19 see column 8, line 54 - column 9, line 9 ---	1-11, 15-27, 31-35
Y	US,A,5 410 335 (M. SAWANO ET AL.) 25 April 1995 see the whole document ---	1-11, 15-27, 31-35
Y	EP,A,0 645 924 (EASTMAN KODAK COMPANY) 29 March 1995 see abstract ---	4-8, 20-24
Y	WO,A,94 17624 (MINNESOTA MINING AND MANUFACTURING COMPANY) 4 August 1994 see page 8, line 3 - line 6 ---	6-8, 22-24

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 January 1997	30.01.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Roeck, A

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/02641

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US,A,4 745 046 (A. L. BORROR ET AL.) 17 May 1988 ---	
A	EP,A,0 279 104 (SEIKO INSTRUMENTS INC.) 24 August 1988 -----	

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No.
PCT/GB 96/02641

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